Specific Comments

Section 2 – Site Background

Section 2.1.1, Site Description, Page 2-1

Comment

Lines 4-11

- The Scope of work should clearly define the boundaries of the site and study areas. The yellow line on Figure 1, page 2-3 indicates the site boundaries. The Regulatory Agencies assume the study area is the entire area as presented in Fig. 1. The Navy should clarify the study area boundaries and use these definitions though out document. For example, SOW states no cap rock is located in the study area, yet it is present on Fig 1 study area but not within site boundary.

Commented [PB1]: Mark, please clarify this portion of the comment.

Comment 1

Lines 25-29

- Similar to the comment the Regulatory Agencies made on the Monitoring Well Installation Work Plan ("MWIWP"), we believe it is incorrect to characterize the Red Hill Navy Supply Well as downgradient from the tanks. The terms "down gradient" and "cross gradient" are used throughout this SOW/WP, however the regulatory agencies believe this SOW/WP needs to reflect the uncertainty about the actual groundwater flow paths in the study area.

  Since the actual downgradient direction in the vicinity of Red Hill has not been adequately defined this sentence should acknowledge that uncertainty, pointing out the importance of this and other investigations to characterize groundwater flow patterns beneath the foot print of the facility. It would be more accurate to state "the assumed down gradient direction" or similar since at this point since we don't know the regional gradient beneath the Facility.

  A consistent distance between the well 2254-01 and the USTs needs to be used. This issue was also discussed during the MWIWP review and changes similar to what was agreed in finalizing the MWIWP need to be made to this SOW/WP. It seems most appropriate to use the distance from the east end of the infiltration gallery to UST 1, which is about 1,500 ft.

Section 2.1.2, Site History, Page 2-2

Comment 2

Lines 18-22

- The construction sequence of tanks is not described accurately. Upper domes were constructed first, cavity for tank barrel and bottom blasted and excavated and then barrel and bottom of tank were constructed.

Comment 3

Lines 36-38

- The statement "Test results from Navy Supply Well 2254-01 and the BWS wells' samples indicated that no petroleum constituents had reached the groundwater in the months following the release" incorrectly paraphrases the Red Hill Storage Facility Task Force Report from 2014. That report indicated that no petroleum compounds were detected in drinking water wells, it did not state that petroleum constituents were not detected in the groundwater. Elevated TPH concentrations detected at RHMW02 after the January 2014 tank 5 release were almost certainly related to that release, indicating that petroleum constituents did reach the groundwater.

Section 2.2.1, Groundwater Protection Plan, Page 2-7

Comment 4

Lines 23-24

- Stating that the GWPP steps are only intended to protect human health from leaks of 10 gallons per minute or less, need justification or explanation. No such limit was found in our review of the GWPP. If the Navy believes this is the purpose of the GWPP they should provide supporting evidence.

Page 2-9
Comment

Lines 15-17

- This paragraph states that "major hydrogeologic barriers" are present near the Oily Waste Disposal Facility that, in combination with other factors, resulted in insignificant contaminant transport from the OWDF to the basal aquifer. The Navy either should describe these barriers in more detail or provide a reference. The presence of hydrogeologic barriers are important in the investigation of contaminant transport in this SOW. If information on their presence was considered in the OWDF investigation existence may be applicable to the Red Hill investigation.

Section 2.3.1.3, RHSF Technical Report, Page 2-11

Comment 5

Lines 14-17

- This section states that the Fate and Transport Modeling conducted in 2004 led the Navy to conclude that valley fills in the North Halawa Valley are effective barriers to particle migration of water beneath the facility. Yet while discussing monitoring locations as part of our review of the MWIWP (July 2016), the Navy seems focused on demonstrating that the South Halawa Valley fill is the more relevant barrier to groundwater flow and resisted suggestions from the Regulatory Agencies to investigate the extent and nature of the North Halawa Valley fill. This paragraph seems to support the Regulatory Agencies view that the North Halawa Valley should be further investigated as part of this workplan.

Section 2.3.1.5, Type 1 Letter Report, Page 2-12

Comment 6

Lines 34-40

- This paragraphs states that a groundwater gradient of 0.00022 ft/ft was reported toward well 2254-01, while a gradient of 0.00028 ft/ft was reported to the northwest. This is not consistent with numerous statements throughout the SOW/WP that well 2254-01 is downgradient from the USTs while the Halawa Shaft is cross gradient from the USTs as it appears the greatest gradient is to the northwest. The groundwater flow direction (i.e. effective gradient) is currently unresolved and one of the purposes of the proposed work is to remove the uncertainty.

Section 2.3.2.2, Groundwater Monitoring Program, Page 2-14

Comment 7

Overall comment on section 2.3.2.2

Rather than simply providing the data in a narrative form, which makes it more difficult to visualize data trends, this section should include figures for monitoring well location that plot the data over time for the contaminants of most concern.

Comment 8

Lines 36-39

- This description of the TPH-d trends at RHMW01 fails to note the increasing trend in concentration since January 2015. This paragraph should be amended to note the increasing trend of TPH-d concentrations since that date. As currently written, the paragraph implies that TPH-d concentrations continue to decrease since 2005 and that statement is not supported by the data.

Page 2-15,

Comment 10

Lines 20-21

- The contention that the very low COPC (primarily TPH-d) concentrations detected at RHMW05 suggest that contamination is not migrating downgradient is really an overstatement of the facts as we currently understand them. Since the groundwater flow patterns are not resolved the direction of contaminant migration is likewise unresolved.

Section 2.3.2.2, Groundwater Monitoring Program, Page 2-16

Comment 11

Lines 11-16

- This description of the COPC detections at RHMW04 fails to note the generally increasing trend in TPH-d since January 2015. The Regulatory Agencies wish to note that the location of RHMW04 and the fact that TPH-d has been detected implies that there is some component of groundwater flow that moves in a northeasterly direction.

Section 3.5.2, Site Geology, Page 3-7

Comment 12

Line 1

- This sentence describes the lava beds as "nearly horizontal". However there is a dip to the lava flows and the direction of dip is important to understanding how fuel product may move in the vadose zone. The Regulatory Agencies believe an acknowledgement of the potential for these beds to dip is important. This paragraph should include a sentence stating that characterizing the strike and dip of the lava flows is important for understanding any product migration in the vadose zone outside of the concrete cocoon of the tanks and will be conducted as part of the overall hydrologic investigation.

Section 3.6.1, Regional Hydrogeology, Page 3-7

Comment 13

Lines 20-31

- These two paragraph state that there are two principle aquifer types in Hawaii. It fails to mention high level dike confined water that is an important aquifer type and supplies municipal drinking water in many locations on Oahu.

Section 3.6.2, Site Hydrogeology, Page 3-8

Comment 14

Lines 4-7

- It would be more accurate to state the Red Hill overlies the Waimalu Aquifer System of the Pearl Harbor Aquifer Sector and the Moanalua Aquifer System of the Honolulu Aquifer Sector. The two aquifers almost equally bisect the Red Hill Facility.

Comment 15

Lines 17-20

- As mentioned in comment 5 above, the Regulatory Agencies believe it is important for this workplan to include further investigation of the extent and nature of the North Halawa Valley fill. This paragraph states that the North Halawa Valley fill is likely acting as a barrier to flow between the Moanalua and Waimalu aquifers.

Comment 16

Lines 26-31

- See Comment 1 above

Comment 17

Page 3-13, Figure 6, Geological Cross Section (Transverse)

- As we stated in our comments to the MWIWP, the Navy provides no basis for the extent of the Valley Fill and Saprolite areas as depicted in Figure 6. The Navy needs to provide supporting documentation or references to support the characterization of the valley fill or clearly indicate that the extent of the valley fill depicted on the figure is speculative and not supported by geologic evidence.

Comment 18

- Figure 6 should be updated to show the new location of proposed RHMW11 as well as an indicator to show the additional depth of RHMW11 in the event that bedrock is not encountered at the target depth.

Comment 19

- As stated in our comments on the MWIWP, Figure 6 incorrectly shows the Halawa Shaft terminating within the valley fill. The Halawa Shaft is actually a horizontal infiltration gallery in the basalt northwest of the valley fill. The Halawa Shaft is bored into the wall of North Halawa Valley so the depiction of a vertical well located in the center of the valley is inaccurate.

Comment 20

- Remove the word "sporadic" from Note 1 of Figure 3. Note 1 should be revised to, "Existing well logs show a complex subsurface comprised of alternating pahoehoe and a'a lava flow with clinker zones, fractures, and voids."

Comment 21

Page 3-15, Figure 7, Longitudinal Cross Section

- Delete the word "Geological" from the title of this figure since no geologic features are depicted in this figure.

Section 3.6.2.2, Groundwater Levels and Hydraulic Gradients, Page 3-17

Comment

This section should include an introductory discussion of flat gradient, measurement/survey error, pumping, and seasonal and tidal effects on gradient.

Commented [PB2]: Mark, please expound.

Comment 22

Lines 2-24

- The description of the hydraulic flow characteristics of the various rock types would be more appropriate in Section 3.6.1, Regional Hydrogeology.

Comment

Lines 32-35

- The SOW should include a map depicting the capture zone and showing which wells were affected by the pumping test. Water drawdowns should be shown as measurement in feet.

Comment 23

Lines 36-43

- It should be noted, and as described by D. Oki of the USGS, that USGS/HBWS pumping test done in May 2015 did see a response on the Red Hill side of the North and South Halawa Valleys to changes in pumping stress at the Halawa Shaft. A careful evaluation of the 2006 aquifer test responses also indicate a possible response across the Halawa Valley Fills.

Section 3.7, Geological Conceptual Site Model

Comment

- The Navy should follow the DOH Technical Guidance Manual, Section 3.3 guidelines for the Conceptual Site Model (CSM) development. The Navy should state representative site environmental conditions with respect to environmental hazards, such as site conditions, extent of contamination, contaminant pathways and potential receptors. Then present the CSM specific to Red Hill. For the CSM the Navy should use tank construction information, available boring logs, barrel logs, pump tests and analytical history. The CSM should include a discussion of the two potential contaminant pathways, a release from the tank that flow out to the rock formations, and a release from tank that flows down within the concrete cocoon.

Section 3.7.4, Red Hill Vadose Zone, Page 3-28

Comment 24

Lines 14-22

- The contention that RHMW07 is not in hydraulic communication with the other Red Hill wells is not borne out by the USGS/HBWS pumping test. The water level in RHMW07 did vary in response to pumping stresses as did other wells located at the Facility. It is true that the connection must be through some hydraulic barrier to account for the abrupt change in water between RHMW07 and nearby wells. The Navy postulates that the barrier could be a dike and this is certainly within the realm of possibility. These dikes, if they exist, will also greatly influence the groundwater flow direction in a way that is not predictable from water level observations alone. Also, the discussion in these lines do not seem to fit in a description of the vadose zone.

Comment 25

- The SOW/WP proposes that the Red Hill area may be a dike complex. This contention comes with serious implications. First is that the assumption the geology can be modeled as an Equivalent Porous Medium becomes invalid since the scale of dikes are 100s to 1,000s of meters. These heterogeneities will not be averaged out over the scale of concern that is also 100s to 1000s of meters. These statements also fail to show how the density of dikes if present could meet the definition of a dike complex that is more 100 dikes per mile (Takasaki and Mink, 1984). There are no identified dikes in the Red Hill area yet there are deeply incised valleys that should reveal a dike complex if one was located there. However, the Regulatory Agencies do acknowledge that the anomalous water levels in RHMW07 and Moanalua DH43 well as well as the late stage eruptions makai of the facility indicate some dikes and other intrusives could be present.

Section 3.7.4, Red Hill Vadose Zone, Page 3-29

Lines 8-12

Commented [PB3]: I think we need to provide an opinion as to how a vadose zone assessment could be accomplished.

- It is true that numerical modeling of NAPL transport the vadose zone would be fraught with such uncertainty as to make this effort meaningless. However, a vadose zone assessment is critical and ample data exists to significantly increase our understanding of the fate and transport of fugitive fuel as it moves through the vadose zone. Knowledge of likely migration paths and amount of NAPL residual held in the vadose zone are important parameters for evaluating risk to the groundwater and to drinking water.

Section 4 – Scope of Work

Specific Comments

Section 4.2 Task 2: Investigate Light Non-Aqueous-Phase Liquid (LNAPL), Page 4-2

Lines 31-41

- The only approach for investigating any LNAPL and the risk posed to groundwater and drinking water is an electrical resistivity survey in the lower tunnel. The likely interference from reinforcement metals in the floor of the tunnel and of the similar resistivity characteristics of air and LNAPL significantly reduce the likely hood of gaining useable data. There is an eight year history of soil vapor reading, and a longer history of groundwater level and contamination data. It seems that collaborating these data sets with environmental data sets such as precipitation could yield much valuable data about LANPL and other contamination in the vadose zone.

Section 4.3 – Task 3: Identify Chemicals of Potential Concern, Page 4-5

Lines 5-10

- This work plan seems to categorically exclude the possibility that the TPH detected in OWDF MW1 could come UST releases. It must be noted that:
  - OWDBMW-1 is part of the NAVFAC agreed upon GWPP monitoring network for evaluating groundwater contamination from the USTs. The source of TPH at this well is not known and the flow paths beneath the facility are poorly understood. No definitive conclusions can be made as to the source of the elevated TPH at OWDFMW-1, so releases from the USTs remain a possibility.
  - Figure 3-7 of the EarthTech (2000) report shows groundwater from the beneath the OWDB flowing in a direction roughly toward well 2254-01. The groundwater flow direction in this figure is also consistent with recently acquired groundwater chemistry. Whatever the source of the recurring TPH spikes at OWDFMW1, chemistry at this well should be viewed as indicating what may be captured by drinking water well 2254-01.
  - If it is the desire of the Navy to remove OWDFMW1 from consideration in the Red Hill risk assessment, then an approach needs to be included that answers the critical questions as to the source and nature of the TPH at his well and the groundwater flow patterns beneath the OWDB relative to well 2254-01.

Section 4.5, Task 5: Update the Existing Groundwater Model, Page 4-9

Lines 14-36

- See comments for Appendix H

Section 5.5.2 – Tier III Human Health Risk Assessment, Page 5-11

Lines 15-30

- Although the regulatory documents for a Tier III Health Risk Assessment are referenced, no approach is given as how this evaluation will be done. It is well established that HDOH EALs are exceeded routinely at the site, necessitating the need for a site cleanup or a detailed Tier III risk assessment.
- To be protective of groundwater important specific limits that should be evaluated are the soil vapor action limits. A confirmed release occurred at the site resulting in significantly elevated soil vapor readings. However, the current actions levels were not exceeded until months after the release. An analysis of the historical soil vapor data should be done to establish the normal range, then a more protective action level established. Specific procedures to be followed if a new soil vapor action level is exceeded should be included in the updated GWPP

Section 6.2.1 – Groundwater Sampling, Page 6-3

Lines 20-22

- OWDFMW-1 currently lacks a downhole pump. This should also be noted an information provided on how this critical well will be sampled.

Section 6.2.2 – Topographic Surveying, Page 6-3

Lines 4-12

- The surveying procedures in these sections are suitable for the majority of the environmental investigation sites managed by the Navy. In the case of Red Hill, the Navy has chosen to characterize the groundwater gradient over an area extending from the Moanalua Ridge to west of the North Halawa Valley as the approach to evaluate possible migration paths of contamination. This is a regional groundwater problem that spans two aquifer systems. This requires that the water level elevations relative to those at the Facility be measured accurately over distances of miles. This is a difficult undertaking. Lack of precise Top of Casing Elevations (TOC) of the wells has been a problem with Red Hill investigations from the beginning. Two efforts have been made to resolve this issue, TEC in 2009 and USGS in 2015. Both of these efforts relied on GPS that has vertical accuracies in the tenths of feet. Again, we recognize doing accurate TOC elevations over an area this large is a challenging effort. We recommend a two-step process:
  1) Do a sensitivity analysis to determine an acceptable level accuracy that will be required to adequately characterize the groundwater flow gradient.
  2) Consult with the NOAA National Geodetic Survey to develop a survey plan that can attain the needed level of accuracy. The contact information is given below.
  Edward E. Carlson
  National Geodetic Survey
  808-532-3205
  ed.carlson@noaa.gov

Section 6.2.3 – Synoptic Water Level Reading, Page 6-3

Lines 14-31

- A week long monitoring of groundwater elevations at multiple locations will give a good time-averaged snap shot of relative water level elevations. However, the Navy is proposing to answer critical, but currently unanswered questions, using water level measurements and groundwater modeling. Key to current investigation is to characterize the response of monitoring locations to pumping stresses. The two previous aquifer response tests lasted for about a month. A review of both tests show that the aquifer may not recovered completely to pre-test conditions. Currently the response of Red Hill area wells to pumping stresses at the Halawa Shaft may not have been adequately answered during the 2015 USGS/BWS aquifer tests due to interfering pumping at well 2254-01. We recommend that data loggers be retained in critical wells after the week long status-quo water level monitoring period and a series of coordinated (between HBWS and Navy PWS) aquifer tests be done to definitively measure the hydraulic connection between the Red Hill area and the Halawa municipal well source area.

Section 6.2.4 – Proposed Electrical Resistivity Survey, Page 6-4 & 6-5

Lines 32-41 and Lines 1-10

- From Don Thomas – The Navy needs to further evaluate the practical limitations of the site (e.g. locations of pipelines, presence of rebar in the concrete of the tunnel) to define the study design to ensure that interpretable and usable data are recovered. Since they propose to do a resistivity survey down the tunnel, the rebar in the underlying concrete if present, will likely blank out everything.
- Myself – The Navy should consider a resistivity transect at the lower to the northwest edge of the Facility to see if they can image the high chloride shallow groundwater present in OWDFMW1, RHMW07, and RHMW06. This could be helpful in evaluating groundwater flow paths within the facility.

Section 6.3, Field and Analytical Sampling Program, Page 6-6

Table 9

- Alkalinity should be added to the list since it also is a chemical indicator of natural attenuation. Also, verbally the Navy has indicated that a suite of major ion samples will collected. There is no indication of this in the Sampling Program. The regulatory agencies would strongly encourage a round of major ion and dissolved silica analysis to be characterize the groundwater chemistry of the study area. This analysis and other important groundwater chemistry can be done in collaboration with the on-going University of Hawaii research.

Section 7.1.2.2, Matrix Interference, Page 7-1

Lines 30-40

- We would like the Navy to better define the term “biogenic hydrocarbons” since it seems that this term is also used to propose that elevated hydrocarbon detections are not related to the UST site.

Appendix H – Work Plan / Scope of Work, Groundwater Flow and Contaminant Fate and Transport Modeling

Specific Comments

Section 1 – Background, Page H-1

Line 38

- The Tripler Army Medical Center drinking water supply wells are located in close proximity to the HBWS Moanalua Wells and should be included in the description of potentially affected wells.

Section 2. Objectives of the Planned Groundwater Modeling, Page H-2

Lines 35-36

- The modeling objectives, and the groundwater study in general, fail to address the primary risk driver. This is the migration of LNAPL due to a large release. As estimated by the 2007 F&T modeling, contaminant concentrations could degrade to less than environmental action levels about 1,200 ft downgradient from an LNAPL source. However, during a large release, the LNAPL would form a relatively thin layer on the water table that could extend significant distances. The important risk driver is not the dissolved plume alone, but rather the combined fate and transport of the LNAPL and dissolved plume. Characterizing the direction and the distance an LNAPL plume will from a large release will migrate needs to be critically evaluated.

Section 3.1 – Conceptual Site Model, Page: H-7

Lines 12-17

- Again, the SOW/WP refers to a probability of dikes being present. If it is believed dikes are present, this will greatly complicate the groundwater modeling and some approach should be articulated to deal with this difficulty.

Lines 31-34

- The UIC line is a State of Hawaii boundary between what is considered a drinking water aquifer and a non-drinking water aquifer. The EPA does not recognize this line and considers water makai of the UIC line also a potential source of drinking water.

Lines 36-41

- The description also pre-supposes a mauka to makai groundwater gradient. Determining the groundwater gradient is one of the tasks of the groundwater investigation, thus it is inappropriate to make statements such as "The infiltration located hydraulically downgradient from the USTs and intercepts most of the water that be affected by releases….". Also, 18 mgd is not a sustained pumping rate for well 2254-01.

Section 3.2 Groundwater Monitoring, Water Levels, and Hydraulic Gradients, Page H-8

Lines 21-22

- The contention that transport of LNAPL to the valley streams could not occur is incorrect. Much of the tank profiles extend above the elevation of the streams (See SOW/WP Figure 7). Due to fractures and in the concrete cocoon, angle iron brackets around the tanks, etc. it is not inconceivable that the fuel would enter the rock formation at an elevation above the bottoms of the tanks, and above the stream bed.

Lines 27-34

- The contention that "No dissolved petroleum constituent concentrations, however, have been detected at concentrations approaching the solubility limit of JP-5…. Suggesting that LNAPL is not present on the groundwater table" is not correct. TPH-d has been detected at concentrations greater than 5 mg/L on numerous occasions at RHMW02. The EPA considers dissolved concentrations equal to or greater than 1% of the solubility limit of a DNAPL as an indication that NAPL is present near the monitoring point (EPA, 2009). Although we are dealing with LNAPL, the principals stated in EPA (2009) still applies. The 1% limit (45 µg/L) has been exceeded at RHMW02 for the history of monitoring at this well and routinely at other wells. Also, the contention that low TPH concentrations at RHMW01 suggest that dissolved petroleum compounds are not migrating off site at levels of concern is equally unsupportable since there is no measureable hydraulic gradient between RHMW02 and RHMW01 based on the monthly water level measurements.

Section 3.2 Groundwater Monitoring, Water Levels, and Hydraulic Gradients, Page H-11

Lines 6-7

- See previous comments on this issue. But basically, these numbers indicate a stronger gradient to the NW than to the SW.

Section 3.3.1 Basal Aquifer, Page H-11

Line 26

- Basal aquifers, particularly in the study area, are generally considered to be dike free.

Lines 39-43

- The hydraulic conductivity value the SOW/WP cites as being used by Oki is the transverse not longitudinal value. Oki used 4,500 ft/d for the longitudinal hydraulic conductivity. Also, the referenced to ratio of vertical to horizontal hydraulic conductivity is out dated. Currently the USGS uses 1:100 or 1:200 or more in their models. See Oki (2005), or Gingerich (2012) for example.

Section 3.4 Previous Numerical Groundwater Flow Modeling, Page H-13

Lines 15-17

- The contention that the longitudinal hydraulic conductivity used in the Rotzoll and El-Kadi (2007) calibrated flow model was substantially higher than other relevant groundwater studies in incorrect. The Kh values are nearly identical to those used by Oki (2005) for a model that included the same area.

Lines 21-27

- Groundwater flow patterns and well zones of contribution modeled by Rotzoll and El-Kadi (2007) can't be used to assess contamination risk to well 2254-01 or to the Halawa Shaft. This model was essentially not calibrated. Due to TOC elevation survey issues the regional groundwater gradient was not correctly characterized. Also, there was only a single calibration point used in the Red Hill Ridge so local groundwater flow paths were not be properly tested. This is not an indictment of the modelers, but rather it simply states that new data has come to light that brings into question the model results.
- The reference to Figure H-3 is not valid since to assess the impact of valley fills on contaminant migration since the cross-section shown is well downslope from the USTs and the Halawa Shaft. This figure is also conceptually incorrect in that it shows a depressed water table in the valley fill. A mounded water table would actually be expected due to the low permeability of the alluvium and the increased infiltration from the stream bed.

Lines 36-38

- As with the flow model, the Fate and Transport Model was essentially uncalibrated since there was no field data to compare modeled degradation rates with. Drawing conclusions about degradation rates must be done with caution. As stated in Section 4.5.2, page 4-11, third paragraph F&T model report, the much lower RT3D BTEX package default degradation rates produced a much closer agreement with degradation rates compiles from 39 Air Force remediation sites.

Section 3.5 Evaluation of Fuel Sources, Page H-14

Lines 24-25

- The SOW/WP cites Potter and Simmons (1998) as providing the water solubility limit of Benzene in JP-5 fuel. The maximum solubility of 0.75 mg/L was actually calculated as part of the 2007 F&T modeling effort. No JP-5 chemical analysis could be found that gave a weight percentage for Benzene. A worst case was assumed based on the ASTDR

Toxicological Profile for JP-A, JP-5, and JP-8. JP-A has a maximum Benzene concentration of 0.02 weight percent.

Section 3.6, Previous Reactive Transport Simulations, Page H-14
Lines 31-39

- This particular paragraph cites the transport model conclusion that well 2254-01 is the only drinking water source that would be impacted by contamination from the Facility. However, since the underlying flow model was not properly calibrated and the F&T degradation rates were not validated the modeling conclusions must be used with caution.

Section 3-6, Previous Reactive Transport Simulations, Pahe H-18
Lines 21-24

- The SOW/WP correctly cites that early detections of a thin free product layer were followed by a long history of no detections. The absence of any product detection at the monitoring wells after January 2008 is an artifact of redefining what constituted a product detection. Prior to January 2008, any product tone from the oil/water interface detector constituted a detection. However, since many of the detections seemed spurious as indicated by the detection only on the initial meeting of the probe with water surface and not repeatable, the definition of a detection was changed to requiring a conformation detection by re-lowering the probe to the water table surface.

Lines 25-32

- This paragraph states that JP-5 was released in January 2014. Actually it was JP-8. However, chemical properties are similar.

Lines 36-40

- The statement "..the few groundwater samples in which BTEX compounds have been detected….." is misleading since detections of ethylbenzene and xylenes frequently occur at RHMW02. Although the concentrations, as stated in the SOW/WP, are below environmental action levels these compounds are detected nevertheless.

Section 4.1, Model Selection, Page H-19
Line 25

- The stated model assumption that all simulated wells fully penetrate the aquifer is incorrect and needs to be changed.

Lines 33-39

- It is important to note that while the model did replicate the relative drawdowns due to changes in pumping stress, there were significant absolute errors. It is also incorrect to state that the agreement between modeled and simulated drawdowns confirms that the Porous Equivalent Medium assumption is valid. Voss (2011) states that the accuracy of a model calibration should be view with some caution and other aspects of the modeling effort given more weight.

Section 4.2, Model Domain, Layers, Grid, and Boundary Conditions, Page H-21
Lines 4-19

- A better discussion/justification of boundaries is needed. This discussion should include the type of boundary condition and justification of the selected boundary condition. Since the Rotzoll and El-Kadi model results were released new groundwater gradient data has come to light showing the potential for inter-aquifer flow, which necessitates closer evaluations of the model boundaries. This is also a recommendation from the USGS.

Section 4.4, Calibration, Page H-21
Lines 27-41

- These lines seem to describe conceptual model construction rather than calibration.

Section 4.4, Calibration, Page H-22
Lines 12-14

- Estimating recharge is a very involved process. Suggest using recharge values already calculated by the USGS (Engott, et al, 2015 and Izuka et al., 2016).

Lines 15-22

- Porosity is an important parameter for contaminant transport. Porosity should be included in the list of parameters to be varied when calibrating the transient model. Also, there is reference in these lines to acquiring pumping test data from the USGS. This is confusing since the USGS data are available on-line. However, the USGS data should be supplemented with pumpage and water level data from the HBWS.

Lines 31-32

- The 15 percent RMSE calibration criteria needs more justification. Cite modeling standards etc. that list acceptable model accuracy standards.

Section 4.5, Predictive Flow Modeling, Page H-31
Lines 37-39

- All but the base case scenario seem to be very vague. At this point in the planning process this may not be unreasonable. However, the input on the future scenarios needs to extend beyond the AOC parties to the HBWS and CWRM since they are stakeholders in this process. One scenario that should be run is a drought scenario using the USGS drought period recharge coverage for Oahu (Engott et al., 2015).
- Also, as suggested by the USGS, the change in boundary conditions resulting from modifying the model from the base scenario need to be carefully evaluated and appropriate new boundary conditions incorporated.

Section 5, Technical Approach for Refining the Contaminant Fate and Transport Model, Page H-33
Line 2

- It is important to note that production of CO_2 due to natural attenuation of hydrocarbons increases the alkalinity of the water. Alkalinity should be included in the NAPs analysis list.

- General Note: Both the groundwater flow, and fate and transport model technical approaches uses the word "Refine". This implies minor revisions. It should be considered that major changes may be necessary to adequately assess the risk to groundwater and drinking water posed by the Facility may be major.

Section 5.1, Objections, Page H-33
Lines 18-29

- The AOC – SOW **Section 7.2, Contaminant Fate and Transport Model Report**, states that "The purpose of the Contaminant Fate and Transport Model Report is to utilize the Groundwater Flow Model to improve the understanding of the potential fate and transport, degradation, and transformation of contaminants that have been and could be released from the Facility". It should be explicitly stated as a modeling goal that the fate and transport of a major release be rigorously characterized. To accomplish this a large release needs to be characterized from the time it leaves the concrete cocoon, until the plume becomes immobile (i.e. LNAPL transport) and the dissolved plume reaches steady state (i.e. through degradation, transformation, and dilution).

Section 5.2, Model Selection, Page H-34
Lines 1-3

- This is inaccurate. There were insufficient data to attempt to develop site specific reaction rates. Reaction rates were tested during sensitivity analysis and it was determined that reaction rates borrowed from the Hill AFB site may have been too optimistic. We concur with the uncertainties regarding the modeled RT3D degradation rates. However, these uncertainties exist even if MT3D is used.

Section 5.2, Model Selection, Page H-35
Lines 1-16

- It is unclear in the SOW/WP how a first-order degradation rate will be selected, and more importantly, validated. Typically this requires having concentrations at two or more locations along a groundwater flow path and knowing the velocity along that flow path. The SOW/WP needs to document how these two parameters (i.e. flow path and transport velocity) will be quantified with confidence and how the results will be used to develop defensible first order degradation rates.

- There are serious plumbness issues with TAMC MW2. Being a 2" well with a long depth to groundwater, its casing snakes around severely biasing water levels measured at this well. Also, it unlikely that a True Vertical Depth survey can be done on this well due to the kinks in the casing.

Section 5.2, Model Selection, Page H-35

Lines 20-21

- It is difficult to see how decay rates can be estimated using time series data. The first order decay equation that is likely to be used does not account for advective transport of contamination away from the source area or sorption within the source area. The first order decay constant calculated from the time series data at RHMW02 would be a combination of many processes including; degradation, transformation, advective transport of contamination into and away from the vicinity of this well, and sorption. There are too many undefined variables to do the calculation with confidence. Some method needs to be articulated to replace some of the unknown variables with measured parameters. The most straight forward way to do this is with a well-designed and executed tracer test where the critical transport parameters can be measured.

Section 5.3, Model Setup, Page H-35

Lines 22-39

- Although the header says "Model Setup" the text only justifies using MT3D versus RT3D. There is nothing else in this section that deals with model setup other than stating it will use the same grid as the MODFLOW model. Since MT3D requires the MODFLOW solution to simulate transport there is no flexibility in using any other grid.

Section 5.5 Model Parameters, Page H-36

Lines 10-13

- The SOW/WP incorrectly states that the longitudinal dispersivity used in the 2007 F&T model was 20 m. The actual value was 112 ft (34 m). It is likely that the 20 m value stated came from the Lahaina tracer test report. This needs to be clarified and corrected. Also, the porosity value of 0.05 for the 2007 F&T model was chosen to be consistent with SWAP modeling. Inverse modeling during the flow simulations estimated a porosity of 0.031. If the inverse modeling porosity were used in the transport model, the contaminant migration velocity would increase by a factor of 1.6. This does need to be considered when developing the model and interpreting the results.

Section 5.5.4, Dispersivity, Page H-38

Lines 3-5

- The dispersivity value stated in this section differs from that in Table 2. Of greater consequence as this section points there is a broad range of literature dispersivity values. The parameter can be directly estimated from a well-designed and executed tracer test.

Section 5.5.5, Degradation, Page H-38
Lines 7-21

- Multiple processes are working on these concentrations. Each has to be accounted for in some way to estimate a first order decay coefficient. Particularly problematic is the spatial distribution of contaminant concentration. Unless the groundwater flow direction is aligned with track of the monitoring wells and the groundwater flow velocity is known with certainty, then calculating the first order decay coefficient becomes very problematic. Wiedimeier et al., 1996 documents a method to estimate degradation rates by comparing the contaminant concentration trends with that of a tracer. In the case of this investigation it would likely be necessary to introduce a conservative tracer. So again, a well-designed and executed tracer test can provide valuable data for F&T modeling.

Section 5.5.6, Initial Conditions; and Section 5.6, Calibration, Page H-38
Lines 22-37

- There is insufficient information to determine whether or not the model is capable of assessing contaminant F&T, and what role the boundary conditions will play.

Section 5.7 Predictive Transport Simulations, Page H-39
Lines 1-13.

- The SOW/WP only proposes to simulate the dissolved phase transport from an arbitrarily defined stationary LNAPL source. This is a repeat of what was done in 2007. Since it is a repeat it is uncertain of why it needs to be done again in a numerical F&T model. There many other critical F&T processes that need to be evaluated but are not included in the SOW/WP (e.g. vadose zone transport, LNAPL transport on the water table, etc).
- The purpose of the modeling is to define the risk to groundwater and to the areas drinking water sources posed by the current and future potential leaks. When considering a future leak, the F&T of a large LNAPL release must be considered. The proposed modeling only evaluates the groundwater flow paths and the F&T of the dissolved plume after the LNAPL becomes immobile. Also, there is insufficient detail in the SOW/WP for the regulatory agencies to evaluate whether or not the dissolve phase F&T portion of the risk assessment will be adequately validated.

References

Earth Tech Inc. 2000. Remedial Investigation Phase II – Red Hill Oily Waste Disposal Facility – Halawa, Oahu, Hawaii; Volume 1, Technical Report. Prepared for Dept. of the Navy, Naval Facilities Engineering Command, Pearl Harbor, Hi. September 2000

Engott, J.A., Johnson, A.G., Bassiouni, Maoya, and Izuka, S.K., 2015, Spatially distributed groundwater recharge for 2010 land cover estimated using a water-budget model for the Island of O'ahu, Hawaii. U.S. Geological Survey Scientific Investigations Report 2015–5010, 49 p., [HYPERLINK "http://dx.doi.org/10.3133/sir20155010"]

Gingerich, S.B., and Engott, J.A., 2012, Groundwater availability in the Lahaina District, west Maui, Hawai'i: U.S. Geological Survey Scientific Investigations Report 2012–5010, 90 p.

Izuka, S.K. 1992. Geology and Stream Infiltration of North Halawa Valley, Oahu, Hawaii. U.S. Geological Survey Water-Resources Investigations Report 91-4197. 25 p.

Izuka, S.K., Engott, J.A., Bassiouni, Maoya, Johnson, A.G., Miller, L.D., Rotzoll, Kolja, and Mair, Alan, 2016, Volcanic aquifers of Hawai'i—hydrogeology, water budgets, and conceptual models: U.S. Scientific Investigations Report 2015-5164, 158 p., [HYPERLINK "http://dx.doi.org/10.3133/sir20155164."]

Lau, L.S. and Mink, J.F. 2006. Hydrology of the Hawaiian Islands. University of Hawaii Press. Pg. 137

Macdonald, G.A., Abbott, A.T., and Peterson, F.L. 1986 Volcanoes in the sea: Honolulu, Hawaii, University of Hawaii Press. P. 143-147

Oki, D.S., 2005, Numerical Simulation of the Effects of Low-Permeability Valley-Fill Barriers and the Redistribution of Ground-Water Withdrawals in the Pearl Harbor Area, Oahu, Hawaii: U.S. Geological Survey Scientific Investigations Report 2005-5253, 111 p.

Rotzoll, K. and El-Kadi, A.I. 2007. Numerical Ground-Water Flow Simulation for Red Hill Fuel Storage Facilities, NAVFAC Pacific, Oahu, Hawaii. Prepared for TEC Inc. August 2007

Stearns, H.T. 1985. Geology of the State of Hawaii, 2nd Edition. Pacific Books, Palo Alto, Ca, Pg. 77

Takasaki, K.J. and Mink, J.F. 1985. Evaluation of Major Dike-Impounded Ground-Water Reservoirs, Island of Oahu – U. S. Geological Survey Water-Supply Paper 2217. 83 p.

TEC, Inc., 2007. Red Hill Bulk Fuel Storage Facility – Final – Contaminant Transport Simulations Using Numerical Models for Tier 3 Risk Evaluation, Pearl Harbor, Hawaii. Prepared for Dept. of the Navy, Naval Facilities Engineering Command, Pacific, Pearl Harbor, Hi. August 2007

U.S. EPA, 2009. Assessment and Delineation of DNAPL Source Zones at Hazardous Waste Sites. EPA/600/R-091119